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Pressure Distributions on Sphere-Cone Radomes in Uniform and Gradient Flows

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Lexington, Massachusetts

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY

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Group 71

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ABSTRACT

A series of wind tunnel tests on two radome models, composed of truncated spheres on conical bases, in both a uniform and two power law gradient flow conditions are described in this report. The data from these tests is presented in the form of actual pressure coefficients and as Fourier coefficients which have been best-fitted to the experimental data.

Comparisons are presented to show the manner in which these pressure distributions vary from each other for the differing model and flow conditions.

Accepted for the Air Force
Franklin C. Hudson
Chief, Lincoln Laboratory Office

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LIST OF SYMBOLS

$A = \pi R^2$ = reference area

$C_D = \frac{\text{Drag}}{q_{ref} A}$

$C_L = \frac{\text{Lift}}{q_{ref} A}$

$C_p = \frac{p - p_o}{q}$

h = pressure head measured by manometer or piezometer ring

K = constant

p = local pressure on model

p_o = static pressure

$q = \frac{1}{2} \rho V^2$ = dynamic pressure

R = radius of radome

S' = meridional distance measured from top of radome

$S = \frac{S'}{R}$

V = wind velocity

Z = distance above ground plane

Z_o = reference height above ground plane

α = exponent

ρ = air density

θ = azimuth angle

ϕ = meridional angle

PRESSURE DISTRIBUTIONS ON SPHERE-CONE RADOMES IN UNIFORM AND GRADIENT FLOWS

I. INTRODUCTION

A series of tests has been conducted on two radome scale models in the M. I. T. Wright Brothers Wind Tunnel. The models were truncated spheres with conical base sections. Each of the models was tested in a uniform flow and two power law gradient flows with a velocity variation, V, as a function of height, Z, given by

$$V = V_o \left(\frac{Z}{Z_o}\right)^{\alpha}$$

where V_o is a reference velocity at a reference height, Z_o, above the ground plane. For these tests, α was equal to zero (uniform), one-sixth and one-fourth.

The purpose of these tests, which were carried out in support of the Northeast Radio Observatory Corporation (NEROC) Study Program, was to determine wind pressure distributions on large sphere-cone radomes in non-uniform gradient flows. At the time these tests were conducted, there was no existing data for the pressure distributions on this type radome in gradient flows.

This report briefly describes the models and the test conditions and presents the data that was obtained.

II. DESCRIPTION OF THE MODELS

The configurations of the two models tested are shown in Figure 1. The height of the two models was kept constant at 24-1/2 inches measured

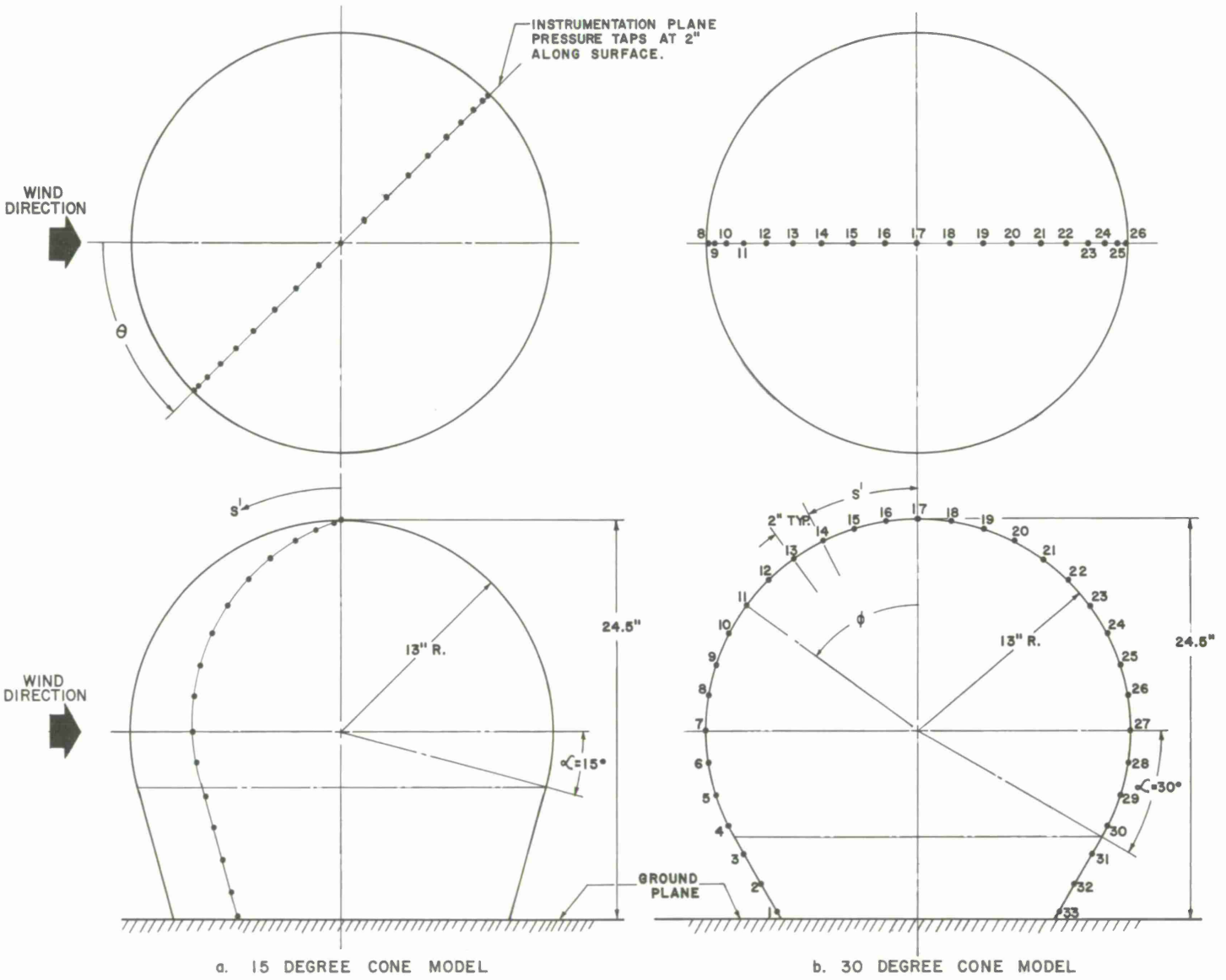

Fig. 1. Test models and instrumentation description.

from the mounting surface to the top of the model. The radius of the spherical portion of the model was 13 inches in both tests. The difference between the two models was in the relative proportion of the sphere to the cone section. In the first case, the sphere extended 15 degrees below the equator of the sphere and in the second case, 30 degrees below the equator. A conical section which was tangent to the sphere at the sphere-cone junction completed the base of the model. The height of the conical section was selected to keep the overall heights of the models the same.

The actual model construction (mahogany) consisted of a common spherical section which extended 15 degrees below the equator and two different base sections giving the two conical geometries. When assembled, each model was bolted to a metal plate that was, in turn, bolted to a splitter plate mounted in the tunnel. The model was sanded smooth and coated with clear lacquer. Figure 2 illustrates the model mounted on the splitter plate in the tunnel.

As shown in Figure 1, the models were instrumented with pressure taps on one complete great circle. The taps were spaced at intervals of approximately 2 inches of arc length along the surface for a total of 33 pressure taps on each model.

III. TEST PROGRAM

During these tests, the primary measurements consisted of pressure tap readings from the 33 taps mounted on the models. In order to obtain a complete pressure distribution, successive test runs were made with the instrumentation plane being rotated with respect to the wind direction as measured by the angle θ, shown in Figure 1. Indexing increments of 15

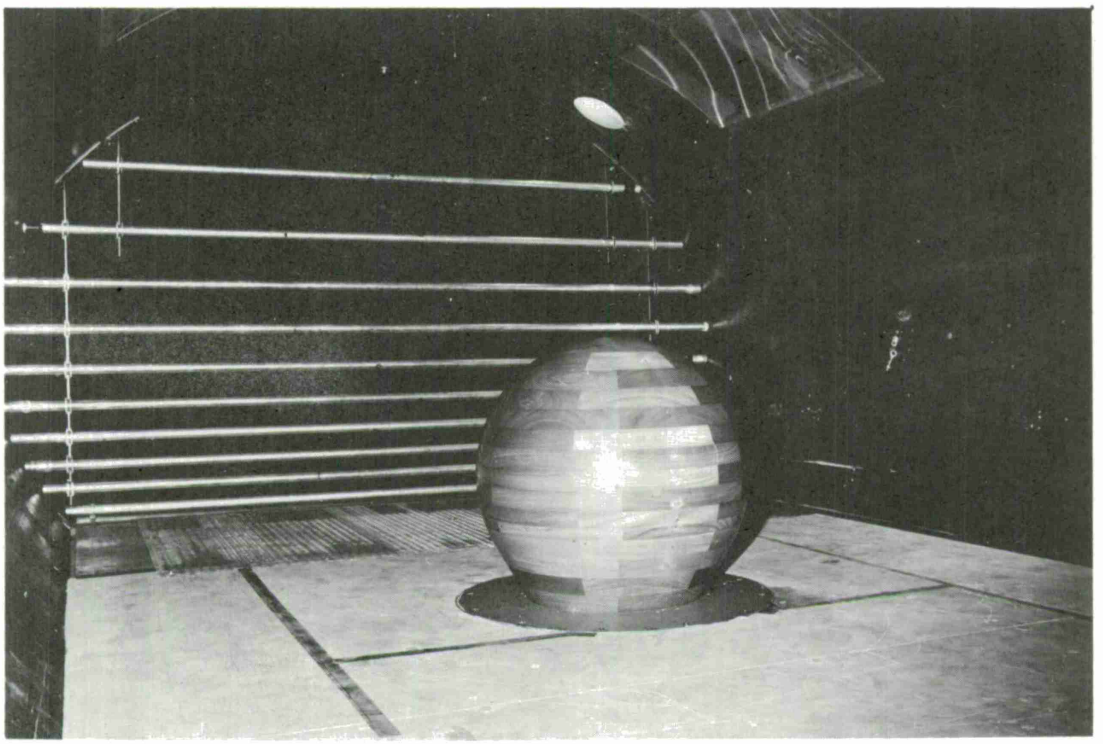

Fig. 2. Model in tunnel with 1/4 power gradient fence.

degrees were used for intervals between 0 and 195°. The complete sphere-cone distribution was obtained with an overlap at one position ($\theta = 195^{\circ}$) for taps 1 - 16 and 18 - 33. Since the structure is rotationally symmetric, cross-correlation of the data can be performed at these points.

For all runs, the nominal tunnel speed was approximately 100 mph. In the case of the uniform flow tests, this velocity provides a good index of the overall flow conditions. For the gradient flow conditions, the 100 mph velocity represents the flow velocity near the top of the tunnel.

The velocity gradient for the non-uniform flow tests was produced by a series of horizontal parallel tubes upstream from the model. A view of this arrangement for the 1/4 power gradient is shown in Figure 2. This scheme of producing a gradient flow in a wind tunnel is based on a method by C. F. Cowdrey[1]. In general, the method gave very good results after careful adjustment of the tubular member spacings. Figures 3 and 4 are plots of the dynamic pressure variation as a function of distance above the ground plane. The velocity gradient was measured at three positions, two feet to the east and west of the centerline and on the centerline of the tunnel, to evaluate the uniformity of the flow field. It will be observed that the 1/4 power gradient profile is more uniform than the 1/6 power gradient profile. The reason for this has not been definitely established, although it was found that the flow is very sensitive to the exact spacing of the tubes. The overall accuracy of the gradients obtained in this program

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[1] Cowdrey, C. F., A Simple Method for the Design of Wind-Tunnel Velocity-Profile Grids, NPL Aero Note 1055, National Physical Laboratory, Teddington, England, May 1967.

compares quite favorably with that reported by Cowdrey in his work.

In addition to the 33 pressure taps on the model, several other pressure measurements were made including the following:

a) The static as well as total pressure head on a pitot-static tube located approximately 8 inches below the ceiling of the tunnel. In the case of the uniform flow and 1/6 power gradient tests, the pitot-static tube was approximately 50 inches upstream from the model. For the 1/4 power gradient tests, the pitot-static tube was approximately 5 inches upstream from the model.

b) The wall static pressure at the same streamwise location as the model using a piezometer ring.

c) The total pressure in the settling section of the tunnel.

Alcohol having a specific gravity of 0.806 at 75^{o}F was used in the manometers.

IV. DATA REDUCTION AND RESULTS

Data reduction was accomplished using a digital computer program. All of the direct readings taken in each run were punched on cards. The necessary calculations to compute the pressure coefficients were then carried out automatically and printed out in tabular form. This reduced data is presented in Tables 1 through 18 as a function of the azimuth position of the instrumentation plane (θ) with respect to the wind direction and the distance (S') along the surface of the model. Each pressure tap has a specific location, S', on the model. The coordinates S' and θ are shown

in Figure 1. For convenience in scaling, the coordinate S' has been normalized with respect to the spherical radius, R.

The pressure coefficients, C_p, were calculated from

$$C_p = \frac{\Delta p}{q} = \frac{h_i - h_o}{K\,(h_{ref} - h_o)}$$

where h_i is the height of the i^{th} pressure tap on the model recorded by the manometer board.

h_o is the height of the wall static pressure tap on the manometer board as measured by the piezometer ring.

h_{ref} is the height of the reference total pressure tap on the manometer board.

q = dynamic pressure

K is a suitable constant defined below

The constant K was taken to be 1.0 for the uniform tests. For the gradient flow tests, the constant K was determined from Figures 3 and 4 at a height of 24-1/2 inches above the ground plane. In this way, the dynamic pressure at the top of the model was used as a reference. The value of h_{ref} was measured by the total head in the settling chamber for the uniform and 1/6 power gradient tests and by the total pressure of the pitot-static tube for the 1/4 power gradient tests.

The pressure coefficients presented in Tables 1 - 18 are the results for taps 1 - 17 and taps 17 - 33 separately as well as for the average of the corresponding taps in the two sets. If the model was exactly rotationally symmetric, the taps 1 - 17 would give results that are identical to the

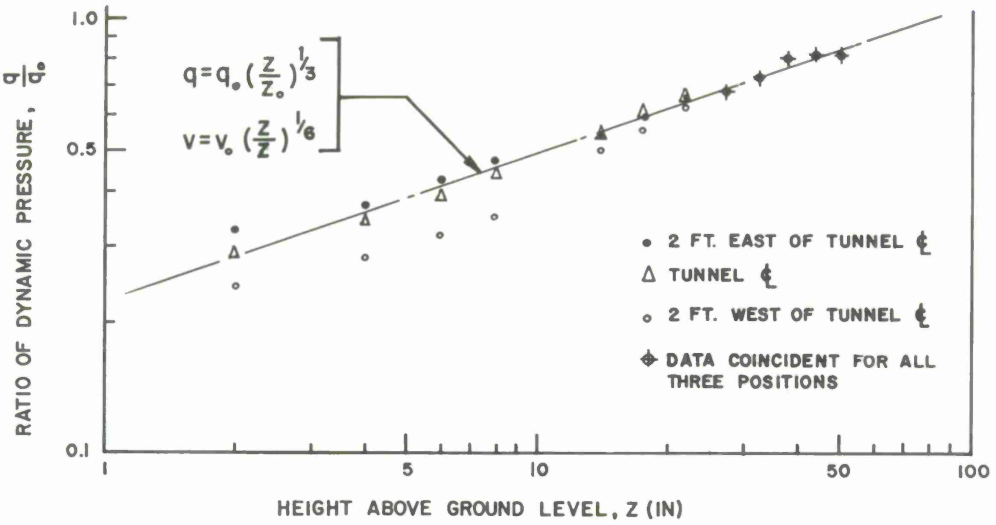

Fig. 3. Measured velocity gradient in tunnel without model for 1/6 power law.

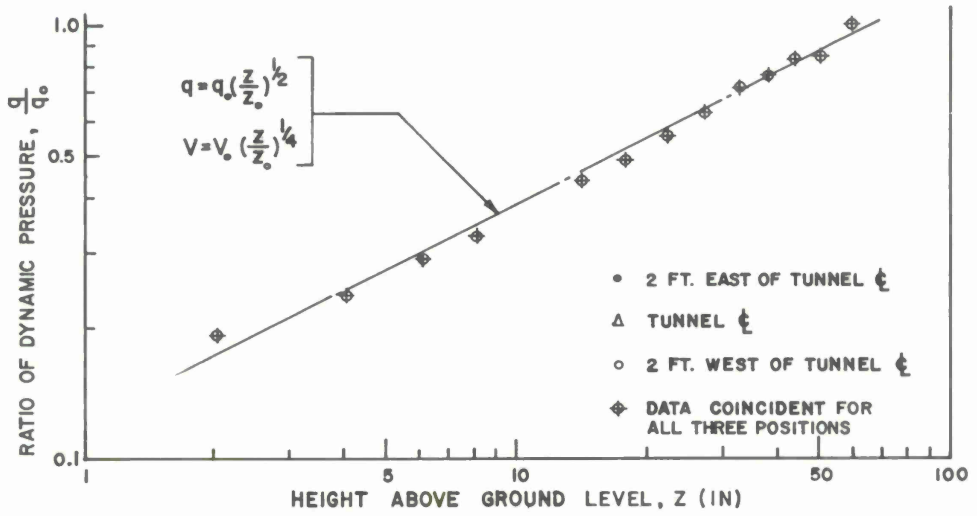

Fig. 4. Measured velocity gradient in tunnel without model for 1/4 power law.

taps 17 - 33, however, as can be seen, the two sets of taps do not give exactly identical results. These differences, however, are quite small with the worst variation in the pressure coefficient being on the order of ± 0.05 whereas most of the variations are within ± 0.02 of the average pressure coefficient. The differences could be caused by any combination of slight variations in the symmetry of the flow, roughness on the model around the pressure tap, and the aperture of the pressure tap itself. The variations noted are considered to be approximately the normal accuracy of wind tunnel experiments.

In addition to reducing the basic data into pressure coefficients, the data reduction program also fits the experimental data to a Fourier series of the form:

$$C_p(S) = C_{p_o}(S) + C_{p_1}(S) \text{ Cos } \theta + \ldots + C_{p_5}(S) \text{ Cos } 5\theta$$

These Fourier coefficients are presented in Tables 19 to 24.

The fundamental and first harmonic coefficients are useful for computing the lift and drag on the models. The lift and drag coefficients C_L and C_O, respectively, for the 15 degree cone sphere model were computed from the following formulae:

$$C_L = \left(\frac{\Delta S'}{R}\right)\left(\frac{R_1}{R}\right) C_{p_{o_1}} \text{ Cos } 105^o + 2\left(\frac{\Delta S'}{R}\right)\sum_{i=2}^{4} C_{p_{o_i}}\left(\frac{R_i}{R}\right)\text{Cos } 105^o$$

$$+ 2\left(\frac{\Delta S'}{R}\right)\sum_{i=5}^{16} C_{p_{o_i}} \text{ Cos } \phi_i \text{ Sin } \phi_i + \frac{1}{4}\left(\frac{\Delta S'}{R}\right)^2 C_{p_{o_{17}}}$$

$$C_D = \frac{1}{2}\left(\frac{\Delta S'}{R}\right)\left(\frac{R_1}{R}\right) C_{p_{l_1}} \text{ Sin } 105^o + \left(\frac{\Delta S'}{R}\right)\sum_{i=2}^{4} C_{p_{l_i}}\left(\frac{R_i}{R}\right) \text{ Sin } 105^o$$

$$+ \left(\frac{\Delta S'}{R}\right)\sum_{i=5}^{16} C_{p_{l_i}} \text{ Sin}^2 \phi_i$$

where the subscript i denotes the tap number, $\phi_i = \frac{S'}{R}\left(\frac{180}{\pi}\right)$ degrees, and R_i is the radius at the i^{th} pressure tap on the conical base. The values for Cp_{o_i} and Cp_{l_i} are the average values taken from Tables 19 through 24. Similar formulae were used for the 30 degree cone-sphere. The results of the calculation are shown in Table 25.

It will be noted that the lift coefficient for the 15 degree cone-sphere is consistently higher than for the 30 degree cone-sphere. On the other hand, the drag coefficient for the 30 degree cone-sphere is consistently higher than for the 15 degree cone-sphere. Both the lift and drag coefficients become progressively smaller as the exponent of the flow gradient increases (for uniform flow, the exponent is zero).

Finally, in Figures 5 through 8, comparisons are made of the pressure distribution with the instrumentation line parallel with the flow. In Figure 5, the two models in uniform flow are compared. In general, the differences between the pressure distributions is small, the greatest differences occurring on the leeward side of the model. In Figures 6 and 7, the two models are compared for the 1/6 power and the 1/4 power gradients, respectively. The differences in the pressure distributions for the two models are smaller than for the uniform flow case. Finally, in Figure 8, a comparison is presented of the pressure distributions for the uniform flow and two gradients on the 15 degree cone-sphere model. It will be noted that the maximum and minimum pressure coefficients decrease progressively as the exponent of the flow gradient increases. On the leeward side of the model ($S'/R < 0$), there is a considerable qualitative difference between the uniform flow and gradient flow pressure distributions. This difference is probably produced by the alteration in the boundary separation conditions produced by the gradient flow.

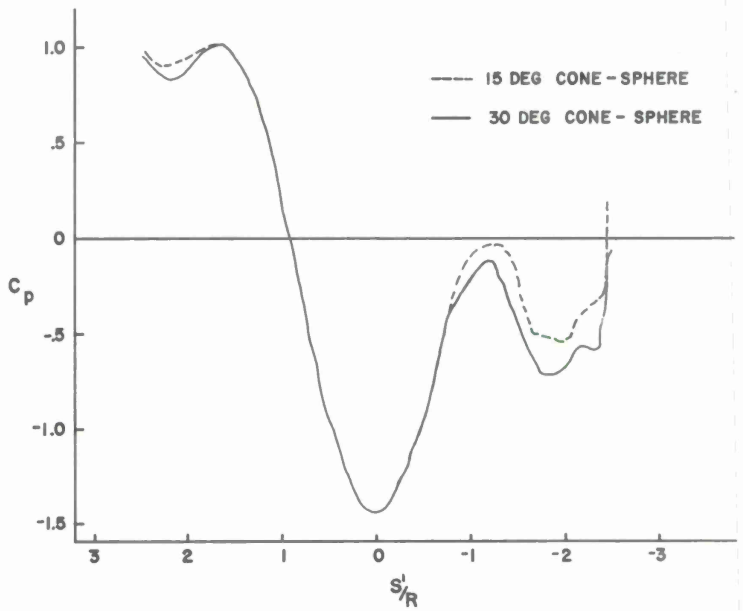

Fig. 5. Pressure distribution on both cone-sphere models for uniform flow at $\theta = 0$.

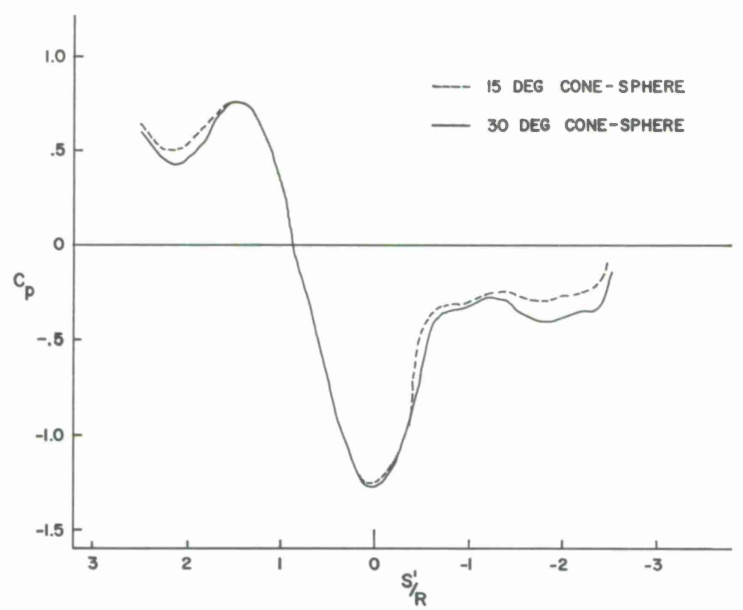

Fig. 6. Pressure distribution on both cone-sphere models for 1/6 power gradient flow at $\theta = 0$.

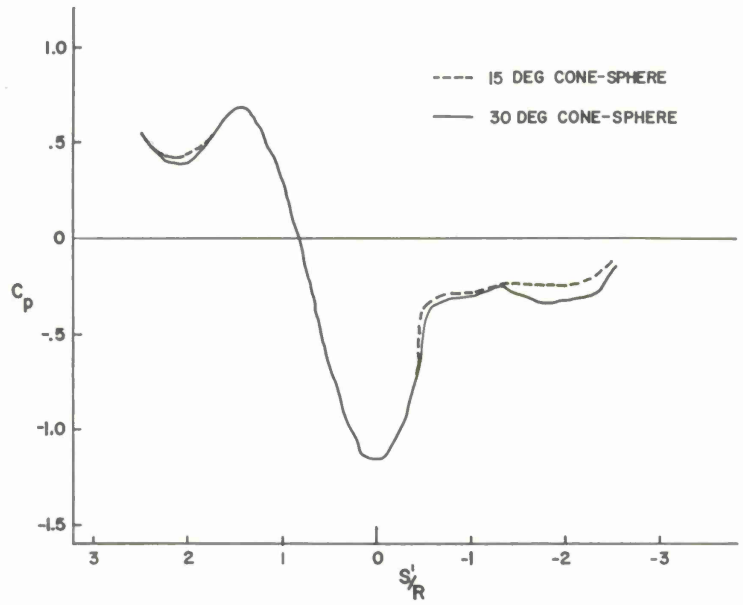

Fig. 7. Pressure distribution on both cone-sphere models for 1/4 power gradient flow at $\theta = 0$.

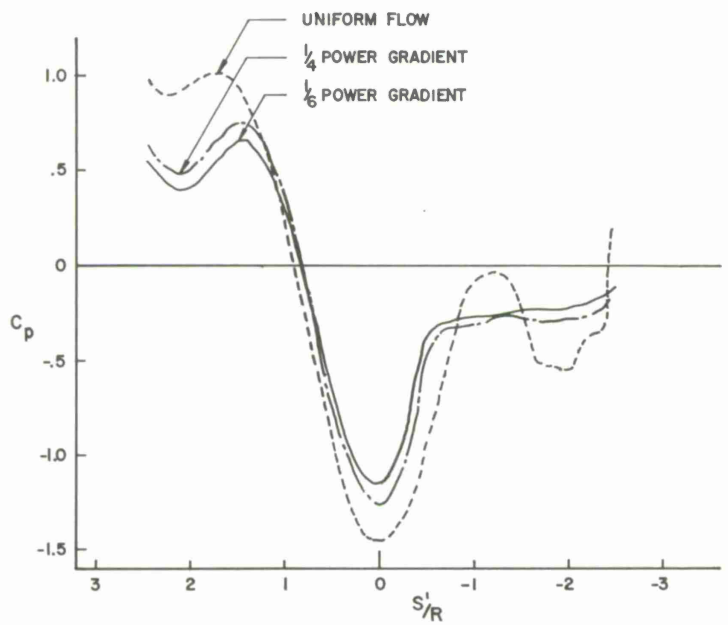

Fig. 8. Pressure distribution on 15-degree cone-sphere for uniform flow and 1/6 and 1/4 power gradients at $\theta = 0$.

TABLE 1

TUNNEL REFERENCE= IN.ALCOHOL
15.CC DEGREE CONE
UNIFORM FLOW 12/18/67

TAPS 1 TO 17

TAP	S/THETA	C.	15.	3C.	45.	6C.	75.	90.	105.	120.	135.	15C.	165.	180.	THETA/S	TAP
1	2.4615	0.98	C.77	0.2C	-0.53	-1.13	-1.20	-0.5C	-0.34	-0.37	-0.55	-0.62	-0.21	0.20	2.4615	1
2	2.3077	C.90	C.7C	C.17	-C.51	-1.06	-1.22	-0.54	-0.36	-0.43	-0.58	-0.67	-0.56	-0.37	2.3077	2
3	2.1538	C.92	C.72	0.22	-0.44	-1.01	-1.25	-0.91	-0.36	-0.45	-0.58	-0.65	-0.56	-0.40	2.1538	3
4	2.0000	0.95	C.78	C.2S	-0.36	-0.95	-1.27	-1.13	-0.45	-0.55	-0.57	-0.63	-0.63	-0.54	2.0000	4
5	1.8462	1.CC	C.82	C.3S	-C.28	-0.87	-1.24	-1.2C	-0.6S	-0.57	-0.62	-0.59	-0.58	-0.52	1.8462	5
6	1.6923	1.01	C.85	C.4C	-0.22	-0.81	-1.20	-1.25	-0.9C	-0.57	-0.66	-0.59	-0.55	-0.50	1.6923	6
7	1.5385	C.96	C.81	C.37	-C.22	-0.8C	-1.20	-1.3C	-1.06	-0.53	-0.58	-0.58	-0.51	-0.29	1.5385	7
8	1.3846	0.83	C.7C	C.3C	-C.25	-C.81	-1.21	-1.33	-1.17	-0.69	-0.42	-0.47	-0.37	-0.08	1.3846	8
9	1.2308	C.63	C.68	C.16	-0.35	-C.85	-1.22	-1.35	-1.22	-0.82	-0.40	-0.27	-0.18	-0.03	1.2308	9
1C	1.0769	0.34	C.24	-C.C7	-C.5C	-0.94	-1.27	-1.38	-1.27	-0.94	-0.56	-0.25	-0.11	-0.05	1.0769	10
11	0.9231	C.C2	-C.C5	-C.32	-C.66	-1.02	-1.30	-1.4C	-1.31	-1.05	-0.74	-0.42	-0.21	-0.15	0.9231	11
12	0.7692	-0.34	-C.3S	-C.5S	-C.86	-1.13	-1.34	-1.42	-1.36	-1.22	-0.91	-0.66	-0.47	-0.40	0.7692	12
13	0.6154	-0.66	-C.7C	-C.84	-1.C2	-1.2C	-1.35	-1.41	-1.38	-1.29	-1.04	-0.87	-0.74	-0.69	0.6154	13
14	0.4615	-C.99	-1.00	-1.C9	-1.19	-1.30	-1.39	-1.42	-1.40	-1.34	-1.27	-1.C9	-0.98	-0.96	0.4615	14
15	C.3077	-1.23	-1.24	-1.29	-1.33	-1.39	-1.42	-1.44	-1.43	-1.40	-1.36	-1.30	-1.28	-1.28	0.3077	15
16	C.1538	-1.41	-1.4C	-1.43	-1.43	-1.44	-1.45	-1.45	-1.44	-1.44	-1.43	-1.41	-1.4C	-1.40	0.1538	16
17	C.0	-1.45	-1.45	-1.47	-1.46	-1.46	-1.46	-1.45	-1.45	-1.45	-1.45	-1.44	-1.45	-1.45	0.0	17

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
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TAPS 17 TO 33

TABLE 2

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.98	0.77	0.17	-0.57	-1.14	-1.09	-0.45	-0.34	-0.37	-0.55	-0.65	-0.25	0.18	2.4615	33
32	2.3077	0.92	0.71	0.17	-0.51	-1.06	-1.13	-0.45	-0.35	-0.44	-0.59	-0.67	-0.52	-0.33	2.3077	32
31	2.1538	0.93	0.73	0.20	-0.47	-1.04	-1.20	-0.82	-0.38	-0.45	-0.59	-0.66	-0.57	-0.40	2.1538	31
30	2.0000	0.95	0.78	0.27	-0.38	-0.97	-1.23	-1.08	-0.45	-0.55	-0.59	-0.64	-0.62	-0.54	2.0000	30
29	1.8462	0.99	0.82	0.33	-0.30	-0.89	-1.21	-1.17	-0.70	-0.59	-0.62	-0.59	-0.58	-0.55	1.8462	29
28	1.6923	1.00	0.84	0.37	-0.26	-0.85	-1.21	-1.25	-0.92	-0.61	-0.67	-0.59	-0.55	-0.53	1.6923	28
27	1.5385	0.96	0.80	0.37	-0.22	-0.80	-1.18	-1.28	-1.04	-0.53	-0.59	-0.59	-0.51	-0.26	1.5385	27
26	1.3846	0.83	0.68	0.27	-0.29	-0.85	-1.21	-1.33	-1.16	-0.65	-0.44	-0.48	-0.34	-0.07	1.3846	26
25	1.2308	0.63	0.49	0.12	-0.39	-0.89	-1.24	-1.36	-1.23	-0.81	-0.39	-0.27	-0.13	-0.02	1.2308	25
24	1.0769	0.35	0.22	-0.10	-0.54	-0.98	-1.28	-1.38	-1.27	-0.92	-0.54	-0.24	-0.08	-0.04	1.0769	24
23	0.9231	0.02	-0.08	-0.35	-0.71	-1.07	-1.31	-1.40	-1.32	-1.03	-0.72	-0.40	-0.19	-0.14	0.9231	23
22	0.7692	-0.32	-0.40	-0.59	-0.87	-1.14	-1.32	-1.40	-1.34	-1.15	-0.84	-0.61	-0.42	-0.38	0.7692	22
21	0.6154	-0.70	-0.77	-0.92	-1.12	-1.31	-1.43	-1.46	-1.39	-1.27	-1.06	-0.89	-0.75	-0.72	0.6154	21
20	0.4615	-1.01	-1.05	-1.12	-1.24	-1.34	-1.41	-1.44	-1.42	-1.34	-1.26	-1.10	-1.18	-1.00	0.4615	20
19	0.3077	-1.25	-1.27	-1.30	-1.36	-1.41	-1.43	-1.45	-1.44	-1.39	-1.35	-1.31	-1.27	-1.27	0.3077	19
18	0.1538	-1.38	-1.38	-1.39	-1.41	-1.42	-1.42	-1.42	-1.42	-1.41	-1.40	-1.39	-1.37	-1.38	0.1538	18
17	0.0	-1.45	-1.45	-1.44	-1.45	-1.45	-1.45	-1.45	-1.46	-1.46	-1.46	-1.47	-1.45	-1.45	0.0	17

TABLE 3

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
UNIFORM FLOW 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1 33	2.4615	C.98	C.77	0.15	-C.55	-1.13	-1.15	-0.48	-0.34	-0.37	-0.55	-0.64	-0.23	0.19	2.4615	1 33
2 32	2.3077	C.91	C.71	C.17	-C.51	-1.06	-1.18	-0.49	-0.36	-0.43	-0.58	-0.67	-0.54	-0.35	2.3077	2 32
3 31	2.1538	C.92	C.73	0.21	-0.45	-1.02	-1.23	-0.87	-0.37	-0.45	-0.59	-0.66	-0.57	-0.40	2.1538	3 31
4 30	2.0000	0.95	C.78	0.28	-C.37	-C.96	-1.25	-1.11	-0.45	-0.55	-0.58	-0.64	-0.62	-0.54	2.0000	4 30
5 29	1.8462	C.99	0.82	0.34	-0.29	-0.88	-1.22	-1.19	-0.69	-0.58	-0.62	-0.59	-0.58	-C.53	1.8462	5 29
6 28	1.6923	1.01	C.84	0.38	-C.24	-C.83	-1.21	-1.25	-0.91	-0.59	-0.67	-0.59	-0.55	-0.52	1.6923	6 28
7 27	1.5385	C.96	0.80	0.37	-0.22	-C.80	-1.19	-1.29	-1.05	-0.53	-0.58	-0.59	-0.51	-0.28	1.5385	7 27
8 26	1.3846	C.83	C.69	C.28	-C.27	-C.83	-1.21	-1.33	-1.17	-C.67	-0.43	-0.48	-0.35	-0.08	1.3846	8 26
9 25	1.2308	C.63	C.58	0.14	-0.37	-C.87	-1.23	-1.35	-1.22	-0.81	-0.40	-0.27	-0.16	-0.03	1.2308	9 25
10 24	1.0769	C.35	C.23	-C.CE	-C.52	-C.96	-1.27	-1.38	-1.27	-0.93	-0.55	-0.24	-0.10	-0.05	1.0769	10 24
11 23	0.9231	C.C2	-C.C7	-C.33	-C.68	-1.05	-1.31	-1.40	-1.32	-1.04	-0.73	-0.41	-0.20	-0.14	0.9231	11 23
12 22	C.7692	-0.33	-C.4C	-C.59	-C.86	-1.13	-1.33	-1.41	-1.35	-1.18	-0.88	-0.63	-0.45	-0.39	0.7692	12 22
13 21	0.6154	-C.68	-C.73	-0.88	-1.07	-1.26	-1.39	-1.44	-1.38	-1.28	-1.05	-0.88	-0.75	-0.71	0.6154	13 21
14 20	0.4615	-1.00	-1.03	-1.11	-1.21	-1.32	-1.40	-1.43	-1.41	-1.34	-1.26	-1.09	-1.08	-0.98	0.4615	14 20
15 19	C.3077	-1.24	-1.25	-1.3C	-1.35	-1.40	-1.43	-1.44	-1.43	-1.40	-1.35	-1.31	-1.28	-1.27	0.3077	15 19
16 18	0.1538	-1.39	-1.39	-1.41	-1.42	-1.43	-1.43	-1.43	-1.43	-1.43	-1.41	-1.40	-1.39	-1.39	0.1538	16 18
17 17	0.0	-1.45	-1.45	-1.46	-1.46	-1.46	-1.45	-1.45	-1.45	-1.46	-1.46	-1.46	-1.45	-1.45	0.0	17 17

TABLE 4

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
UNIFORM FLOW 12/18/67

TAPS 1 TO 17

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	2.4615	0.95	0.73	0.15	-0.47	-0.79	-0.91	-0.53	-0.41	-0.51	-0.51	-0.58	-0.32	-0.09	2.4615	1
2	2.3077	0.87	0.67	0.17	-0.40	-0.81	-1.03	-0.46	-0.41	-0.51	-0.57	-0.65	-0.64	-0.58	2.3077	2
3	2.1538	0.85	0.68	0.24	-0.32	-0.77	-1.06	-0.70	-0.45	-0.54	-0.59	-0.65	-0.64	-0.58	2.1538	3
4	2.0000	0.90	0.74	0.32	-0.23	-0.72	-1.06	-0.94	-0.48	-0.64	-0.62	-0.65	-0.68	-0.69	2.0000	4
5	1.8462	0.97	0.82	0.40	-0.17	-0.71	-1.09	-1.07	-0.62	-0.74	-0.68	-0.63	-0.68	-0.73	1.8462	5
6	1.6923	1.00	0.86	0.45	-0.13	-0.69	-1.09	-1.15	-0.78	-0.69	-0.69	-0.64	-0.64	-0.64	1.6923	6
7	1.5385	0.97	0.82	0.42	-0.15	-0.72	-1.12	-1.22	-0.96	-0.61	-0.63	-0.65	-0.64	-0.47	1.5385	7
8	1.3846	0.83	0.71	0.34	-0.20	-0.75	-1.14	-1.28	-1.10	-0.63	-0.46	-0.57	-0.54	-0.24	1.3846	8
9	1.2308	0.63	0.53	0.20	-0.30	-0.81	-1.17	-1.31	-1.18	-0.80	-0.41	-0.32	-0.25	-0.09	1.2308	9
10	1.0769	0.35	0.26	-0.03	-0.46	-0.91	-1.22	-1.35	-1.24	-0.92	-0.56	-0.25	-0.14	-0.07	1.0769	10
11	0.9231	0.02	-0.04	-0.28	-0.63	-1.01	-1.26	-1.38	-1.30	-1.05	-0.73	-0.42	-0.23	-0.16	0.9231	11
12	0.7692	-0.35	-0.40	-0.58	-0.85	-1.13	-1.32	-1.41	-1.35	-1.22	-0.91	-0.67	-0.49	-0.41	0.7692	12
13	0.6154	-0.67	-0.69	-0.82	-1.00	-1.21	-1.33	-1.40	-1.37	-1.29	-1.05	-0.88	-0.77	-0.70	0.6154	13
14	0.4615	-1.03	-0.99	-1.07	-1.17	-1.30	-1.36	-1.41	-1.40	-1.35	-1.27	-1.08	-0.99	-0.96	0.4615	14
15	0.3077	-1.23	-1.22	-1.27	-1.32	-1.39	-1.41	-1.43	-1.43	-1.40	-1.34	-1.29	-1.30	-1.29	0.3077	15
16	0.1538	-1.43	-1.39	-1.41	-1.43	-1.45	-1.44	-1.45	-1.45	-1.45	-1.42	-1.41	-1.42	-1.41	0.1538	16
17	0.0	-1.45	-1.43	-1.46	-1.45	-1.48	-1.45	-1.46	-1.45	-1.46	-1.44	-1.44	-1.47	-1.46	0.0	17

TABLE 5

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
UNIFORM FLOW 12/18/67

TAPS 17 TO 33

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.95	0.74	0.11	-0.68	-0.72	-0.47	-0.44	-0.42	-0.45	-0.50	-0.49	-0.28	-0.12	2.4615	33
32	2.3077	0.87	0.67	0.14	-0.53	-0.75	-0.72	-0.40	-0.43	-0.49	-0.58	-0.64	-0.61	-0.55	2.3077	32
31	2.1538	0.85	0.67	0.17	-0.46	-0.78	-0.87	-0.72	-0.46	-0.53	-0.60	-0.66	-0.63	-0.57	2.1538	31
30	2.0000	0.90	0.73	0.27	-0.32	-0.72	-0.95	-0.93	-0.47	-0.61	-0.62	-0.66	-0.66	-0.67	2.0000	30
29	1.8462	0.97	0.80	0.34	-0.27	-0.74	-1.03	-1.07	-0.62	-0.70	-0.67	-0.63	-0.64	-0.72	1.8462	29
28	1.6923	1.01	0.84	0.37	-0.23	-0.75	-1.10	-1.17	-0.88	-0.68	-0.74	-0.64	-0.62	-0.73	1.6923	28
27	1.5385	0.97	0.80	0.37	-0.21	-0.74	-1.10	-1.22	-0.98	-0.55	-0.72	-0.64	-0.56	-0.47	1.5385	27
26	1.3846	0.84	0.68	0.27	-0.28	-0.80	-1.17	-1.29	-1.11	-0.62	-0.57	-0.57	-0.41	-0.25	1.3846	26
25	1.2308	0.63	0.45	0.12	-0.38	-0.86	-1.20	-1.33	-1.19	-0.77	-0.42	-0.32	-0.17	-0.12	1.2308	25
24	1.0769	0.34	0.22	-0.11	-0.54	-0.97	-1.26	-1.37	-1.24	-0.92	-0.50	-0.23	-0.10	-0.22	1.0769	24
23	0.9231	0.02	-0.09	-0.35	-0.70	-1.06	-1.30	-1.39	-1.28	-1.02	-0.69	-0.38	-0.20	-0.34	0.9231	23
22	0.7692	-0.32	-0.40	-0.59	-0.86	-1.13	-1.32	-1.39	-1.32	-1.14	-0.82	-0.57	-0.41	-0.33	0.7692	22
21	0.6154	-0.72	-0.79	-0.93	-1.13	-1.32	-1.43	-1.45	-1.37	-1.27	-1.04	-0.87	-0.74	-0.52	0.6154	21
20	0.4615	-1.03	-1.08	-1.14	-1.25	-1.36	-1.43	-1.44	-1.40	-1.35	-1.24	-1.09	-1.02	-0.95	0.4615	20
19	0.3077	-1.25	-1.28	-1.28	-1.35	-1.41	-1.44	-1.44	-1.42	-1.40	-1.34	-1.29	-1.25	-1.20	0.3077	19
18	0.1538	-1.38	-1.40	-1.38	-1.39	-1.42	-1.42	-1.42	-1.41	-1.42	-1.39	-1.37	-1.35	-1.31	0.1538	18
17	0.0	-1.46	-1.47	-1.44	-1.44	-1.46	-1.45	-1.46	-1.45	-1.48	-1.45	-1.46	-1.43	-1.45	0.0	17

TABLE 6

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
UNIFORM FLOW 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1 33	2.4615	0.95	0.73	0.13	-0.58	-0.76	-0.69	-0.49	-0.41	-0.48	-0.51	-0.53	-0.30	-0.10	2.4615	1 33
2 32	2.3077	0.87	0.67	0.16	-0.47	-0.78	-0.87	-0.43	-0.42	-0.50	-0.57	-0.64	-0.62	-0.57	2.3077	2 32
3 31	2.1538	0.85	0.67	0.20	-0.39	-0.78	-0.97	-0.71	-0.45	-0.54	-0.59	-0.65	-0.64	-0.57	2.1538	3 31
4 30	2.0000	0.90	0.74	0.30	-0.27	-0.72	-1.00	-0.94	-0.48	-0.63	-0.62	-0.65	-0.67	-0.68	2.0000	4 30
5 29	1.8462	0.97	0.81	0.37	-0.22	-0.72	-1.06	-1.07	-0.62	-0.72	-0.67	-0.63	-0.66	-0.72	1.8462	5 29
6 28	1.6923	1.01	0.85	0.41	-0.18	-0.72	-1.10	-1.16	-0.83	-0.68	-0.71	-0.64	-0.63	-0.68	1.6923	6 28
7 27	1.5385	0.97	0.81	0.40	-0.18	-0.73	-1.11	-1.22	-0.97	-0.58	-0.67	-0.65	-0.60	-0.47	1.5385	7 27
8 26	1.3846	0.84	0.70	0.31	-0.24	-0.77	-1.15	-1.28	-1.11	-0.63	-0.52	-0.57	-0.48	-0.24	1.3846	8 26
9 25	1.2308	0.63	0.51	0.16	-0.34	-0.84	-1.19	-1.32	-1.18	-0.79	-0.41	-0.32	-0.21	-0.11	1.2308	9 25
10 24	1.0769	0.35	0.24	-0.07	-0.50	-0.94	-1.24	-1.36	-1.24	-0.92	-0.53	-0.24	-0.12	-0.15	1.0769	10 24
11 23	0.9231	0.02	-0.06	-0.31	-0.67	-1.03	-1.28	-1.38	-1.29	-1.04	-0.71	-0.40	-0.21	-0.25	0.9231	11 23
12 22	0.7692	-0.33	-0.40	-0.58	-0.85	-1.13	-1.32	-1.40	-1.33	-1.18	-0.86	-0.62	-0.45	-0.37	0.7692	12 22
13 21	0.6154	-0.69	-0.74	-0.87	-1.06	-1.26	-1.38	-1.43	-1.37	-1.28	-1.04	-0.88	-0.75	-0.61	0.6154	13 21
14 20	0.4615	-1.03	-1.04	-1.11	-1.21	-1.33	-1.40	-1.43	-1.40	-1.35	-1.26	-1.09	-1.01	-0.95	0.4615	14 20
15 19	0.3077	-1.24	-1.25	-1.27	-1.33	-1.40	-1.42	-1.44	-1.42	-1.40	-1.34	-1.29	-1.28	-1.25	0.3077	15 19
16 18	0.1538	-1.41	-1.40	-1.40	-1.41	-1.44	-1.43	-1.43	-1.43	-1.44	-1.40	-1.39	-1.39	-1.36	0.1538	16 18
17 17	0.0	-1.45	-1.45	-1.45	-1.45	-1.47	-1.45	-1.46	-1.45	-1.47	-1.45	-1.45	-1.45	-1.45	0.0	17 17

TABLE 7

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

TAPS 1 TO 17

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	2.4615	0.64	0.52	0.18	-0.32	-0.73	-0.88	-0.59	-0.27	-0.23	-0.24	-0.25	-0.18	-0.10	2.4615	1
2	2.3077	0.52	0.42	0.09	-0.35	-0.71	-0.87	-0.59	-0.25	-0.25	-0.27	-0.28	-0.25	-0.23	2.3077	2
3	2.1538	0.48	0.40	0.08	-0.33	-0.70	-0.87	-0.68	-0.23	-0.24	-0.28	-0.29	-0.28	-0.26	2.1538	3
4	2.0000	0.53	0.42	0.11	-0.31	-0.68	-0.87	-0.76	-0.26	-0.27	-0.29	-0.30	-0.28	-0.26	2.0000	4
5	1.8462	0.60	0.49	0.18	-0.25	-0.63	-0.85	-0.79	-0.35	-0.28	-0.30	-0.31	-0.30	-0.28	1.8462	5
6	1.6923	0.68	0.58	0.25	-0.16	-0.59	-0.85	-0.86	-0.49	-0.30	-0.32	-0.32	-0.31	-0.29	1.6923	6
7	1.5385	0.76	0.65	0.30	-0.15	-0.58	-0.87	-0.92	-0.63	-0.30	-0.32	-0.32	-0.32	-0.27	1.5385	7
8	1.3846	0.75	0.64	0.30	-0.15	-0.59	-0.89	-0.97	-0.73	-0.33	-0.32	-0.33	-0.31	-0.24	1.3846	8
9	1.2308	0.65	0.54	0.23	-0.21	-0.63	-0.92	-1.01	-0.81	-0.38	-0.31	-0.33	-0.32	-0.25	1.2308	9
10	1.0769	0.45	0.35	0.07	-0.33	-0.71	-0.98	-1.07	-0.91	-0.49	-0.31	-0.32	-0.31	-0.30	1.0769	10
11	0.9231	0.18	0.10	-0.13	-0.48	-0.80	-1.03	-1.11	-0.98	-0.64	-0.33	-0.31	-0.31	-0.31	0.9231	11
12	0.7692	-0.14	-0.20	-0.39	-0.66	-0.92	-1.10	-1.15	-1.06	-0.81	-0.45	-0.33	-0.33	-0.33	0.7692	12
13	0.6154	-0.46	-0.50	-0.63	-0.81	-0.99	-1.11	-1.15	-1.09	-0.93	-0.65	-0.43	-0.35	-0.35	0.6154	13
14	0.4615	-0.79	-0.81	-0.88	-0.98	-1.09	-1.16	-1.17	-1.14	-1.04	-0.88	-0.73	-0.60	-0.55	0.4615	14
15	0.3077	-1.04	-1.03	-1.07	-1.12	-1.16	-1.20	-1.21	-1.19	-1.14	-1.06	-1.00	-0.94	-0.91	0.3077	15
16	0.1538	-1.23	-1.21	-1.22	-1.23	-1.23	-1.23	-1.22	-1.22	-1.21	-1.19	-1.18	-1.16	-1.16	0.1538	16
17	0.0	-1.26	-1.26	-1.26	-1.26	-1.26	-1.25	-1.24	-1.24	-1.24	-1.23	-1.24	-1.24	-1.24	0.0	17

TABLE 8

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

TAPS 17 TO 33

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.63	0.46	0.09	-0.38	-0.78	-0.90	-0.57	-0.26	-0.23	-0.25	-0.26	-0.19	-0.10	2.4615	33
32	2.3077	0.51	0.38	0.06	-0.35	-0.71	-0.83	-0.54	-0.25	-0.25	-0.28	-0.28	-0.25	-0.22	2.3077	32
31	2.1538	0.48	0.35	0.03	-0.37	-0.73	-0.88	-0.64	-0.23	-0.25	-0.28	-0.29	-0.28	-0.26	2.1538	31
30	2.0000	0.51	0.39	0.07	-0.33	-0.70	-0.88	-0.74	-0.26	-0.27	-0.29	-0.30	-0.28	-0.26	2.0000	30
29	1.8462	0.58	0.45	0.15	-0.27	-0.65	-0.86	-0.79	-0.33	-0.28	-0.31	-0.31	-0.30	-0.28	1.8462	29
28	1.6923	0.68	0.53	0.20	-0.23	-0.63	-0.86	-0.86	-0.48	-0.30	-0.33	-0.33	-0.31	-0.30	1.6923	28
27	1.5385	0.75	0.61	0.26	-0.17	-0.58	-0.86	-0.89	-0.62	-0.30	-0.33	-0.33	-0.31	-0.27	1.5385	27
26	1.3846	0.74	0.61	0.25	-0.19	-0.62	-0.91	-0.96	-0.73	-0.32	-0.32	-0.33	-0.31	-0.25	1.3846	26
25	1.2308	0.64	0.52	0.19	-0.25	-0.66	-0.94	-1.01	-0.81	-0.37	-0.32	-0.33	-0.32	-0.26	1.2308	25
24	1.0769	0.44	0.33	0.05	-0.36	-0.74	-0.99	-1.06	-0.90	-0.48	-0.32	-0.33	-0.32	-0.31	1.0769	24
23	0.9231	0.18	0.10	-0.15	-0.50	-0.83	-1.06	-1.11	-0.97	-0.63	-0.34	-0.32	-0.32	-0.32	0.9231	23
22	0.7692	-0.12	-0.19	-0.38	-0.65	-0.91	-1.08	-1.12	-1.02	-0.77	-0.43	-0.33	-0.33	-0.32	0.7692	22
21	0.6154	-0.48	-0.55	-0.70	-0.90	-1.09	-1.21	-1.22	-1.13	-0.95	-0.68	-0.44	-0.35	-0.35	0.6154	21
20	0.4615	-0.79	-0.83	-0.91	-1.01	-1.13	-1.19	-1.21	-1.16	-1.06	-0.90	-0.73	-0.62	-0.58	0.4615	20
19	0.3077	-1.03	-1.05	-1.08	-1.13	-1.19	-1.23	-1.22	-1.20	-1.17	-1.08	-1.01	-0.95	-0.95	0.3077	19
18	0.1538	-1.16	-1.17	-1.18	-1.18	-1.20	-1.19	-1.19	-1.18	-1.18	-1.16	-1.13	-1.12	-1.13	0.1538	18
17	0.0	-1.24	-1.24	-1.24	-1.23	-1.24	-1.24	-1.24	-1.25	-1.26	-1.26	-1.26	-1.26	-1.26	0.0	17

TABLE 9

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1 33	2.4615	0.63	0.49	0.14	-0.35	-0.75	-0.89	-0.58	-0.27	-0.23	-0.25	-0.26	-0.18	-0.10	2.4615	1 33
2 32	2.3077	0.52	0.40	0.07	-0.35	-0.71	-0.85	-0.57	-0.25	-0.25	-0.28	-0.28	-0.25	-0.23	2.3077	2 32
3 31	2.1538	0.48	0.38	0.05	-0.35	-0.71	-0.87	-0.66	-0.23	-0.25	-0.28	-0.29	-0.28	-0.26	2.1538	3 31
4 30	2.0000	0.52	0.41	0.09	-0.32	-0.69	-0.88	-0.75	-0.26	-0.27	-0.29	-0.30	-0.28	-0.26	2.0000	4 30
5 29	1.8462	0.59	0.47	0.16	-0.26	-0.64	-0.86	-0.79	-0.34	-0.28	-0.30	-0.31	-0.30	-0.28	1.8462	5 29
6 28	1.6923	0.68	0.55	0.23	-0.19	-0.61	-0.86	-0.86	-0.49	-0.30	-0.32	-0.32	-0.31	-0.30	1.6923	6 28
7 27	1.5385	0.75	0.63	0.28	-0.16	-0.58	-0.87	-0.90	-0.63	-0.30	-0.32	-0.33	-0.31	-0.27	1.5385	7 27
8 26	1.3846	0.74	0.62	0.28	-0.17	-0.60	-0.90	-0.96	-0.73	-0.32	-0.32	-0.33	-0.31	-0.25	1.3846	8 26
9 25	1.2308	0.65	0.53	0.21	-0.23	-0.64	-0.93	-1.01	-0.81	-0.37	-0.32	-0.33	-0.32	-0.26	1.2308	9 25
10 24	1.0769	0.45	0.34	0.06	-0.34	-0.72	-0.99	-1.06	-0.90	-0.49	-0.32	-0.32	-0.31	-0.30	1.0769	10 24
11 23	0.9231	0.18	0.10	-0.14	-0.49	-0.82	-1.04	-1.11	-0.98	-0.64	-0.34	-0.32	-0.31	-0.32	0.9231	11 23
12 22	0.7692	-0.13	-0.20	-0.38	-0.65	-0.91	-1.09	-1.13	-1.04	-0.79	-0.44	-0.33	-0.33	-0.32	0.7692	12 22
13 21	0.6154	-0.47	-0.52	-0.66	-0.85	-1.04	-1.16	-1.19	-1.11	-0.94	-0.66	-0.44	-0.35	-0.35	0.6154	13 21
14 20	0.4615	-0.79	-0.82	-0.89	-0.99	-1.11	-1.17	-1.19	-1.15	-1.05	-0.89	-0.73	-0.61	-0.57	0.4615	14 20
15 19	0.3077	-1.03	-1.04	-1.08	-1.13	-1.18	-1.22	-1.21	-1.20	-1.16	-1.07	-1.00	-0.95	-0.93	0.3077	15 19
16 18	0.1538	-1.20	-1.19	-1.20	-1.21	-1.21	-1.21	-1.20	-1.20	-1.19	-1.17	-1.16	-1.14	-1.15	0.1538	16 18
17 17	0.0	-1.25	-1.25	-1.25	-1.24	-1.25	-1.24	-1.24	-1.24	-1.25	-1.24	-1.25	-1.25	-1.25	0.0	17 17

TABLE 10

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

TAPS 1 TO 17

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	2.4615	0.59	0.46	0.10	-0.35	-0.51	-0.60	-0.41	-0.32	-0.31	-0.33	-0.33	-0.22	-0.13	2.4615	1
2	2.3077	0.48	0.38	0.07	-0.33	-0.53	-0.65	-0.34	-0.29	-0.33	-0.35	-0.38	-0.37	-0.35	2.3077	2
3	2.1538	0.43	0.34	0.06	-0.30	-0.54	-0.67	-0.48	-0.28	-0.33	-0.35	-0.38	-0.37	-0.35	2.1538	3
4	2.0000	0.43	0.36	0.08	-0.26	-0.53	-0.72	-0.62	-0.30	-0.38	-0.38	-0.39	-0.38	-0.37	2.0000	4
5	1.8462	0.55	0.46	0.17	-0.21	-0.53	-0.75	-0.73	-0.38	-0.40	-0.41	-0.40	-0.40	-0.40	1.8462	5
6	1.6923	0.68	0.58	0.28	-0.14	-0.50	-0.77	-0.81	-0.53	-0.40	-0.42	-0.40	-0.39	-0.38	1.6923	6
7	1.5385	0.75	0.64	0.33	-0.11	-0.52	-0.82	-0.89	-0.67	-0.38	-0.41	-0.41	-0.38	-0.35	1.5385	7
8	1.3846	0.74	0.64	0.33	-0.12	-0.55	-0.85	-0.95	-0.78	-0.40	-0.39	-0.41	-0.37	-0.28	1.3846	8
9	1.2308	0.64	0.55	0.25	-0.18	-0.60	-0.90	-1.01	-0.88	-0.48	-0.36	-0.36	-0.34	-0.27	1.2308	9
10	1.0769	0.44	0.36	0.08	-0.30	-0.69	-0.97	-1.08	-0.95	-0.60	-0.35	-0.33	-0.32	-0.30	1.0769	10
11	0.9231	0.18	0.11	-0.13	-0.45	-0.79	-1.02	-1.13	-1.03	-0.74	-0.42	-0.33	-0.32	-0.33	0.9231	11
12	0.7692	-0.15	-0.20	-0.38	-0.65	-0.91	-1.09	-1.17	-1.11	-0.90	-0.57	-0.37	-0.35	-0.35	0.7692	12
13	0.6154	-0.47	-0.50	-0.63	-0.80	-0.99	-1.12	-1.18	-1.14	-0.99	-0.77	-0.52	-0.40	-0.38	0.6154	13
14	0.4615	-0.80	-0.81	-0.88	-0.98	-1.10	-1.17	-1.20	-1.18	-1.10	-0.96	-0.81	-0.70	-0.65	0.4615	14
15	0.3077	-1.05	-1.04	-1.08	-1.12	-1.18	-1.21	-1.23	-1.23	-1.18	-1.13	-1.05	-1.00	-0.98	0.3077	15
16	0.1538	-1.23	-1.22	-1.24	-1.23	-1.26	-1.24	-1.25	-1.26	-1.25	-1.23	-1.22	-1.20	-1.21	0.1538	16
17	0.0	-1.28	-1.27	-1.28	-1.27	-1.28	-1.27	-1.27	-1.27	-1.27	-1.27	-1.26	-1.26	-1.27	0.0	17

TABLE 11

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

TAPS 17 TO 33

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.58	0.45	0.05	-0.48	-0.57	-0.36	-0.30	-0.27	-0.28	-0.30	-0.27	-0.19	-0.14	2.4615	33
32	2.3077	0.48	0.37	0.03	-0.40	-0.54	-0.42	-0.32	-0.27	-0.30	-0.34	-0.35	-0.35	-0.35	2.3077	32
31	2.1538	0.43	0.32	0.01	-0.39	-0.58	-0.58	-0.47	-0.27	-0.31	-0.35	-0.37	-0.35	-0.35	2.1538	31
30	2.0000	0.46	0.34	0.07	-0.33	-0.55	-0.64	-0.60	-0.29	-0.37	-0.37	-0.38	-0.37	-0.38	2.0000	30
29	1.8462	0.54	0.43	0.13	-0.29	-0.57	-0.72	-0.74	-0.35	-0.40	-0.40	-0.38	-0.38	-0.41	1.8462	29
28	1.6923	0.66	0.54	0.21	-0.22	-0.55	-0.77	-0.83	-0.50	-0.40	-0.42	-0.38	-0.38	-0.40	1.6923	28
27	1.5385	0.75	0.60	0.27	-0.17	-0.54	-0.79	-0.88	-0.62	-0.38	-0.40	-0.38	-0.36	-0.35	1.5385	27
26	1.3846	0.74	0.60	0.26	-0.20	-0.60	-0.85	-0.95	-0.75	-0.39	-0.38	-0.38	-0.35	-0.30	1.3846	26
25	1.2308	0.64	0.51	0.18	-0.26	-0.65	-0.92	-1.02	-0.83	-0.45	-0.36	-0.35	-0.32	-0.28	1.2308	25
24	1.0769	0.45	0.33	0.03	-0.38	-0.74	-0.98	-1.07	-0.92	-0.58	-0.35	-0.33	-0.32	-0.31	1.0769	24
23	0.9231	0.21	0.09	-0.17	-0.52	-0.84	-1.05	-1.12	-1.00	-0.71	-0.40	-0.33	-0.33	-0.33	0.9231	23
22	0.7692	-0.13	-0.20	-0.40	-0.67	-0.93	-1.09	-1.14	-1.04	-0.83	-0.53	-0.36	-0.34	-0.35	0.7692	22
21	0.6154	-0.50	-0.56	-0.71	-0.93	-1.11	-1.23	-1.25	-1.16	-1.00	-0.75	-0.50	-0.39	-0.40	0.6154	21
20	0.4615	-0.81	-0.83	-0.93	-1.05	-1.15	-1.21	-1.23	-1.18	-1.10	-0.96	-0.81	-0.68	-0.68	0.4615	20
19	0.3077	-1.04	-1.07	-1.11	-1.18	-1.22	-1.25	-1.25	-1.22	-1.19	-1.12	-1.05	-1.00	-1.01	0.3077	19
18	0.1538	-1.19	-1.19	-1.21	-1.23	-1.23	-1.23	-1.21	-1.19	-1.20	-1.18	-1.16	-1.15	-1.16	0.1538	18
17	0.0	-1.27	-1.26	-1.26	-1.27	-1.27	-1.27	-1.27	-1.27	-1.28	-1.27	-1.28	-1.27	-1.28	0.0	17

TABLE 12

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	33	2.4615	0.59	0.45	0.07	-0.42	-0.54	-0.48	-0.36	-0.30	-0.30	-0.31	-0.30	-0.21	-0.14	2.4615	1 33
2	32	2.3077	0.48	0.37	0.05	-0.36	-0.53	-0.53	-0.33	-0.28	-0.32	-0.34	-0.36	-0.36	-0.35	2.3077	2 32
3	31	2.1538	0.43	0.33	0.04	-0.35	-0.56	-0.63	-0.47	-0.28	-0.32	-0.35	-0.38	-0.36	-0.35	2.1538	3 31
4	30	2.0000	0.45	0.35	0.08	-0.29	-0.54	-0.68	-0.61	-0.29	-0.37	-0.38	-0.39	-0.38	-0.37	2.0000	4 30
5	29	1.8462	0.55	0.44	0.15	-0.25	-0.55	-0.74	-0.73	-0.36	-0.40	-0.40	-0.39	-0.39	-0.40	1.8462	5 29
6	28	1.6923	0.67	0.56	0.24	-0.18	-0.53	-0.77	-0.82	-0.51	-0.40	-0.42	-0.39	-0.38	-0.39	1.6923	6 28
7	27	1.5385	0.75	0.62	0.30	-0.14	-0.53	-0.80	-0.89	-0.65	-0.38	-0.40	-0.39	-0.37	-0.35	1.5385	7 27
8	26	1.3846	0.74	0.62	0.29	-0.16	-0.57	-0.85	-0.95	-0.76	-0.39	-0.38	-0.39	-0.36	-0.29	1.3846	8 26
9	25	1.2308	0.64	0.53	0.22	-0.22	-0.63	-0.91	-1.01	-0.85	-0.46	-0.36	-0.36	-0.33	-0.27	1.2308	9 25
10	24	1.0769	0.45	0.34	0.05	-0.34	-0.71	-0.97	-1.08	-0.94	-0.59	-0.35	-0.33	-0.32	-0.31	1.0769	10 24
11	23	0.9231	0.19	0.10	-0.15	-0.49	-0.81	-1.04	-1.13	-1.01	-0.73	-0.41	-0.33	-0.32	-0.33	0.9231	11 23
12	22	0.7692	-0.14	-0.20	-0.39	-0.66	-0.92	-1.09	-1.16	-1.08	-0.86	-0.55	-0.36	-0.34	-0.35	0.7692	12 22
13	21	0.6154	-0.48	-0.53	-0.67	-0.86	-1.05	-1.17	-1.21	-1.15	-1.00	-0.76	-0.51	-0.39	-0.39	0.6154	13 21
14	20	0.4615	-0.80	-0.82	-0.91	-1.01	-1.13	-1.19	-1.21	-1.18	-1.10	-0.96	-0.81	-0.69	-0.67	0.4615	14 20
15	19	0.3077	-1.05	-1.05	-1.09	-1.15	-1.20	-1.23	-1.24	-1.22	-1.18	-1.12	-1.05	-1.00	-0.99	0.3077	15 19
16	18	0.1538	-1.21	-1.21	-1.22	-1.23	-1.24	-1.24	-1.23	-1.23	-1.23	-1.20	-1.19	-1.18	-1.19	0.1538	16 18
17	17	0.0	-1.27	-1.26	-1.27	-1.27	-1.28	-1.27	-1.27	-1.27	-1.28	-1.27	-1.27	-1.26	-1.27	0.0	17 17

TABLE 13

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

TAPS 1 TO 17

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	2.4615	0.55	0.43	0.11	-0.30	-0.65	-0.80	-0.57	-0.24	-0.20	-0.21	-0.22	-0.17	-0.13	2.4615	1
2	2.3077	0.46	0.34	0.04	-0.34	-0.66	-0.80	-0.57	-0.23	-0.22	-0.24	-0.23	-0.21	-0.18	2.3077	2
3	2.1538	0.41	0.30	0.03	-0.33	-0.64	-0.79	-0.62	-0.22	-0.21	-0.24	-0.24	-0.24	-0.23	2.1538	3
4	2.0000	0.45	0.32	0.05	-0.30	-0.62	-0.80	-0.69	-0.24	-0.22	-0.24	-0.24	-0.24	-0.23	2.0000	4
5	1.8462	0.52	0.41	0.12	-0.24	-0.58	-0.78	-0.73	-0.30	-0.24	-0.25	-0.26	-0.25	-0.23	1.8462	5
6	1.6923	0.59	0.48	0.19	-0.19	-0.54	-0.78	-1.06	-0.43	-0.24	-0.24	-0.27	-0.26	-0.24	1.6923	6
7	1.5385	0.65	0.54	0.24	-0.18	-0.54	-0.77	-0.84	-0.54	-0.25	-0.27	-0.28	-0.27	-0.24	1.5385	7
8	1.3846	0.65	0.55	0.26	-0.18	-0.54	-0.81	-0.88	-0.64	-0.27	-0.27	-0.29	-0.28	-0.24	1.3846	8
9	1.2308	0.58	0.49	0.19	-0.19	-0.60	-0.84	-0.92	-0.71	-0.30	-0.27	-0.29	-0.28	-0.24	1.2308	9
10	1.0769	0.41	0.32	0.06	-0.30	-0.65	-0.90	-0.98	-0.80	-0.38	-0.27	-0.29	-0.29	-0.27	1.0769	10
11	0.9231	0.17	0.09	-0.13	-0.43	-0.73	-0.95	-1.02	-0.87	-0.51	-0.29	-0.29	-0.29	-0.29	0.9231	11
12	0.7692	-0.13	-0.19	-0.35	-0.60	-0.84	-1.00	-1.06	-0.94	-0.81	-0.35	-0.30	-0.30	-0.29	0.7692	12
13	0.6154	-0.42	-0.46	-0.58	-0.76	-0.92	-1.03	-1.07	-0.98	-0.80	-0.52	-0.34	-0.30	-0.30	0.6154	13
14	0.4615	-0.72	-0.74	-0.81	-0.91	-1.00	-1.07	-1.08	-1.02	-0.91	-0.75	-0.57	-0.45	-0.41	0.4615	14
15	0.3077	-0.95	-0.96	-0.99	-1.03	-1.07	-1.10	-1.11	-1.07	-1.02	-0.95	-0.87	-0.80	-0.77	0.3077	15
16	0.1538	-1.11	-1.11	-1.11	-1.13	-1.12	-1.13	-1.12	-1.10	-1.09	-1.05	-1.06	-1.05	-1.04	0.1538	16
17	0.0	-1.14	-1.13	-1.14	-1.15	-1.14	-1.14	-1.14	-1.13	-1.13	-1.14	-1.13	-1.14	-1.13	0.0	17

TABLE 14

TUNNEL REFERENCE= IN.ALCOHOL
15.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

TAPS 17 TO 33

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.56	0.45	0.14	-0.27	-0.64	-0.78	-0.54	-0.24	-0.20	-0.21	-0.22	-0.18	-0.13	2.4615	33
32	2.3077	0.46	0.37	0.09	-0.28	-0.62	-0.74	-0.54	-0.22	-0.22	-0.23	-0.23	-0.21	-0.18	2.3077	32
31	2.1538	0.42	0.33	0.05	-0.31	-0.65	-0.80	-0.64	-0.23	-0.21	-0.24	-0.24	-0.24	-0.23	2.1538	31
30	2.0000	0.45	0.37	0.10	-0.23	-0.59	-0.77	-0.68	-0.26	-0.22	-0.24	-0.24	-0.24	-0.23	2.0000	30
29	1.8462	0.51	0.41	0.15	-0.21	-0.56	-0.75	-0.73	-0.30	-0.23	-0.25	-0.27	-0.24	-0.23	1.8462	29
28	1.6923	0.59	0.49	0.21	-0.18	-0.55	-0.78	-0.79	-0.43	-0.24	-0.26	-0.27	-0.26	-0.24	1.6923	28
27	1.5385	0.66	0.56	0.27	-0.14	-0.52	-0.78	-0.82	-0.54	-0.26	-0.27	-0.28	-0.27	-0.24	1.5385	27
26	1.3846	0.66	0.55	0.25	-0.16	-0.55	-0.82	-0.88	-0.64	-0.27	-0.27	-0.28	-0.28	-0.24	1.3846	26
25	1.2308	0.58	0.47	0.18	-0.21	-0.59	-0.86	-0.92	-0.72	-0.30	-0.27	-0.28	-0.29	-0.25	1.2308	25
24	1.0769	0.41	0.30	0.04	-0.32	-0.67	-0.90	-1.00	-0.80	-0.38	-0.28	-0.28	-0.29	-0.28	1.0769	24
23	0.9231	0.17	0.08	-0.14	-0.45	-0.75	-0.96	-1.01	-0.87	-0.51	-0.29	-0.28	-0.29	-0.30	0.9231	23
22	0.7692	-0.11	-0.19	-0.35	-0.59	-0.82	-0.97	-1.02	-0.90	-0.64	-0.35	-0.30	-0.30	-0.30	0.7692	22
21	0.6154	-0.42	-0.49	-0.62	-0.79	-0.97	-1.06	-1.08	-1.00	-0.80	-0.52	-0.34	-0.31	-0.30	0.6154	21
20	0.4615	-0.73	-0.76	-0.84	-0.94	-1.02	-1.08	-1.10	-1.04	-0.92	-0.76	-0.59	-0.46	-0.39	0.4615	20
19	0.3077	-0.95	-0.95	-1.01	-1.06	-1.09	-1.12	-1.11	-1.08	-1.03	-0.95	-0.87	-0.81	-0.78	0.3077	19
18	0.1538	-1.07	-1.08	-1.08	-1.10	-1.09	-1.09	-1.08	-1.07	-1.05	-1.03	-1.01	-1.00	-0.99	0.1538	18
17	0.0	-1.13	-1.14	-1.13	-1.14	-1.13	-1.13	-1.14	-1.14	-1.14	-1.15	-1.14	-1.13	-1.14	0.0	17

TABLE 15

TUNNEL REFERENCE= IN.ALCOHOL
15.CC DEGREE CONE
1/4 POWER GRADIENT 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1 33	2.4615	0.56	0.44	0.12	-0.28	-0.65	-0.79	-0.56	-0.24	-0.20	-0.21	-0.22	-0.17	-0.13	2.4615	1 33
2 32	2.3077	0.46	0.35	0.06	-0.31	-0.64	-0.77	-0.56	-0.23	-0.22	-0.23	-0.23	-0.21	-0.18	2.3077	2 32
3 31	2.1538	0.41	0.31	0.04	-0.32	-0.64	-0.80	-0.63	-0.22	-0.21	-0.24	-0.24	-0.24	-0.23	2.1538	3 31
4 30	2.0000	0.45	0.34	0.08	-0.26	-0.61	-0.79	-0.69	-0.25	-0.22	-0.24	-0.24	-0.24	-0.23	2.0000	4 30
5 29	1.8462	0.51	0.41	0.14	-0.23	-0.57	-0.77	-0.73	-0.30	-0.23	-0.25	-0.26	-0.24	-0.23	1.8462	5 29
6 28	1.6923	0.59	0.48	0.20	-0.18	-0.55	-0.78	-0.92	-0.43	-0.24	-0.25	-0.27	-0.26	-0.24	1.6923	6 28
7 27	1.5385	0.66	0.55	0.25	-0.16	-0.53	-0.77	-0.83	-0.54	-0.25	-0.27	-0.28	-0.27	-0.24	1.5385	7 27
8 26	1.3846	0.66	0.55	0.26	-0.17	-0.54	-0.82	-0.88	-0.64	-0.27	-0.27	-0.28	-0.28	-0.24	1.3846	8 26
9 25	1.2308	0.58	0.48	0.19	-0.20	-0.59	-0.85	-0.92	-0.72	-0.30	-0.27	-0.28	-0.29	-0.25	1.2308	9 25
10 24	1.0769	0.41	0.31	0.05	-0.31	-0.66	-0.90	-0.99	-0.80	-0.38	-0.28	-0.29	-0.29	-0.27	1.0769	10 24
11 23	0.9231	0.17	0.09	-0.13	-0.44	-0.74	-0.95	-1.01	-0.87	-0.51	-0.29	-0.29	-0.29	-0.29	0.9231	11 23
12 22	0.7692	-0.12	-0.19	-0.35	-0.60	-0.83	-0.99	-1.04	-0.92	-0.72	-0.35	-0.30	-0.30	-0.29	0.7692	12 22
13 21	0.6154	-0.42	-0.47	-0.60	-0.77	-0.94	-1.05	-1.08	-0.99	-0.80	-0.52	-0.34	-0.31	-0.30	0.6154	13 21
14 20	0.4615	-0.73	-0.75	-0.82	-0.92	-1.01	-1.07	-1.09	-1.03	-0.92	-0.76	-0.58	-0.45	-0.40	0.4615	14 20
15 19	0.3077	-0.95	-0.96	-1.00	-1.04	-1.08	-1.11	-1.11	-1.08	-1.02	-0.95	-0.87	-0.80	-0.78	0.3077	15 19
16 18	0.1538	-1.09	-1.10	-1.10	-1.11	-1.11	-1.11	-1.10	-1.09	-1.07	-1.04	-1.04	-1.02	-1.02	0.1538	16 18
17 17	0.0	-1.13	-1.13	-1.14	-1.14	-1.13	-1.13	-1.14	-1.13	-1.13	-1.14	-1.14	-1.13	-1.13	0.0	17 17

TABLE 16

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

TAPS 1 TO 17

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1	2.4615	0.53	0.40	0.05	-0.34	-0.46	-0.53	-0.36	-0.29	-0.28	-0.29	-0.26	-0.20	-0.13	2.4615	1
2	2.3077	0.44	0.22	0.03	-0.30	-0.48	-0.57	-0.30	-0.27	-0.28	-0.30	-0.31	-0.32	-0.31	2.3077	2
3	2.1538	0.39	0.30	0.02	-0.29	-0.49	-0.62	-0.42	-0.26	-0.28	-0.30	-0.31	-0.32	-0.31	2.1538	3
4	2.0000	0.38	0.30	0.04	-0.25	-0.49	-0.65	-0.54	-0.27	-0.32	-0.32	-0.32	-0.33	-0.32	2.0000	4
5	1.8462	0.47	0.38	0.11	-0.22	-0.49	-0.69	-0.66	-0.34	-0.35	-0.35	-0.32	-0.34	-0.35	1.8462	5
6	1.6923	0.60	0.49	0.22	-0.14	-0.47	-0.71	-0.73	-0.46	-0.34	-0.35	-0.34	-0.34	-0.34	1.6923	6
7	1.5385	0.68	0.57	0.27	-0.12	-0.49	-0.76	-0.81	-0.60	-0.33	-0.35	-0.34	-0.34	-0.31	1.5385	7
8	1.3846	0.68	0.57	0.27	-0.12	-0.50	-0.79	-0.87	-0.70	-0.35	-0.34	-0.34	-0.34	-0.27	1.3846	8
9	1.2308	0.60	0.49	0.20	-0.20	-0.54	-0.83	-0.92	-0.78	-0.40	-0.32	-0.32	-0.32	-0.25	1.2308	9
10	1.0769	0.41	0.33	0.05	-0.29	-0.64	-0.90	-0.98	-0.87	-0.52	-0.32	-0.31	-0.30	-0.29	1.0769	10
11	0.9231	0.20	0.10	-0.13	-0.43	-0.73	-0.92	-1.03	-0.95	-0.66	-0.35	-0.31	-0.31	-0.31	0.9231	11
12	0.7692	-0.13	-0.19	-0.37	-0.60	-0.84	-1.01	-1.08	-1.01	-0.80	-0.48	-0.32	-0.32	-0.32	0.7692	12
13	0.6154	-0.43	-0.46	-0.60	-0.76	-0.93	-1.06	-1.10	-1.05	-0.91	-0.68	-0.42	-0.35	-0.35	0.6154	13
14	0.4615	-0.73	-0.75	-0.84	-0.92	-1.03	-1.09	-1.11	-1.09	-1.00	-0.86	-0.70	-0.60	-0.54	0.4615	14
15	0.3077	-0.98	-0.98	-1.04	-1.06	-1.11	-1.14	-1.14	-1.14	-1.09	-1.02	-0.94	-0.91	-0.89	0.3077	15
16	0.1538	-1.13	-1.14	-1.17	-1.16	-1.17	-1.17	-1.16	-1.16	-1.15	-1.14	-1.11	-1.12	-1.11	0.1538	16
17	0.0	-1.17	-1.16	-1.20	-1.19	-1.19	-1.18	-1.17	-1.18	-1.18	-1.17	-1.16	-1.18	-1.18	0.0	17

TABLE 17

TUNNEL REFERENCE= IN.ALCCHCL
30.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

TAPS 17 TO 33

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
33	2.4615	0.52	0.43	0.09	-0.38	-0.52	-0.37	-0.27	-0.26	-0.26	-0.27	-0.25	-0.17	-0.14	2.4615	33
32	2.3077	0.44	0.35	0.08	-0.30	-0.46	-0.39	-0.25	-0.24	-0.27	-0.30	-0.31	-0.29	-0.30	2.3077	32
31	2.1538	0.38	0.32	0.06	-0.29	-0.48	-0.54	-0.38	-0.24	-0.27	-0.30	-0.33	-0.29	-0.30	2.1538	31
30	2.0000	0.38	0.32	0.08	-0.26	-0.49	-0.58	-0.53	-0.27	-0.32	-0.33	-0.34	-0.32	-0.32	2.0000	30
29	1.8462	0.47	0.41	0.15	-0.19	-0.47	-0.62	-0.63	-0.33	-0.35	-0.35	-0.35	-0.32	-0.34	1.8462	29
28	1.6923	0.59	0.50	0.22	-0.16	-0.49	-0.70	-0.73	-0.47	-0.35	-0.37	-0.35	-0.32	-0.33	1.6923	28
27	1.5385	0.67	0.57	0.28	-0.13	-0.49	-0.73	-0.79	-0.58	-0.33	-0.35	-0.35	-0.32	-0.30	1.5385	27
26	1.3846	0.67	0.56	0.25	-0.16	-0.53	-0.79	-0.87	-0.69	-0.34	-0.34	-0.35	-0.32	-0.26	1.3846	26
25	1.2308	0.58	0.48	0.18	-0.22	-0.59	-0.84	-0.92	-0.78	-0.39	-0.33	-0.33	-0.30	-0.25	1.2308	25
24	1.0769	0.41	0.30	0.04	-0.33	-0.66	-0.90	-0.98	-0.86	-0.50	-0.32	-0.33	-0.30	-0.28	1.0769	24
23	0.9231	0.17	0.08	-0.15	-0.46	-0.76	-0.96	-1.03	-0.92	-0.63	-0.35	-0.33	-0.30	-0.30	0.9231	23
22	0.7692	-0.12	-0.19	-0.36	-0.61	-0.85	-1.03	-1.04	-0.97	-0.75	-0.46	-0.33	-0.31	-0.32	0.7692	22
21	0.6154	-0.44	-0.49	-0.61	-0.81	-0.98	-1.09	-1.11	-1.05	-0.89	-0.65	-0.44	-0.34	-0.34	0.6154	21
20	0.4615	-0.76	-0.79	-0.85	-0.96	-1.06	-1.13	-1.14	-1.09	-1.00	-0.87	-0.71	-0.57	-0.55	0.4615	20
19	0.3077	-0.98	-1.00	-1.02	-1.08	-1.12	-1.16	-1.15	-1.14	-1.08	-1.02	-0.96	-0.89	-0.89	0.3077	19
18	0.1538	-1.11	-1.12	-1.11	-1.13	-1.14	-1.14	-1.11	-1.11	-1.11	-1.09	-1.08	-1.05	-1.05	0.1538	18
17	0.0	-1.18	-1.18	-1.16	-1.17	-1.18	-1.18	-1.17	-1.18	-1.19	-1.19	-1.20	-1.16	-1.17	0.0	17

TABLE 18

TUNNEL REFERENCE= IN.ALCOHOL
30.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

AVERAGE OF TWO TAPS

TAP	S/THETA	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.	THETA/S	TAP
1 33	2.4615	0.53	0.41	0.07	-0.36	-0.49	-0.45	-0.32	-0.27	-0.27	-0.28	-0.26	-0.18	-0.14	2.4615	1 33
2 32	2.3077	0.44	0.34	0.06	-0.30	-0.47	-0.48	-0.27	-0.26	-0.27	-0.30	-0.31	-0.31	-0.30	2.3077	2 32
3 31	2.1538	0.39	0.31	0.04	-0.29	-0.48	-0.58	-0.40	-0.25	-0.28	-0.30	-0.32	-0.31	-0.31	2.1538	3 31
4 30	2.0000	0.38	0.31	0.06	-0.26	-0.49	-0.62	-0.54	-0.27	-0.32	-0.32	-0.33	-0.32	-0.32	2.0000	4 30
5 29	1.8462	0.47	0.39	0.13	-0.20	-0.48	-0.66	-0.64	-0.34	-0.35	-0.35	-0.34	-0.33	-0.34	1.8462	5 29
6 28	1.6923	0.60	0.49	0.22	-0.15	-0.48	-0.70	-0.73	-0.46	-0.35	-0.36	-0.34	-0.33	-0.34	1.6923	6 28
7 27	1.5385	0.67	0.57	0.27	-0.13	-0.49	-0.74	-0.80	-0.59	-0.33	-0.35	-0.35	-0.33	-0.30	1.5385	7 27
8 26	1.3846	0.67	0.57	0.26	-0.14	-0.51	-0.79	-0.87	-0.69	-0.35	-0.34	-0.35	-0.33	-0.27	1.3846	8 26
9 25	1.2308	0.59	0.48	0.19	-0.21	-0.57	-0.84	-0.92	-0.78	-0.40	-0.32	-0.33	-0.31	-0.25	1.2308	9 25
10 24	1.0769	0.41	0.32	0.04	-0.31	-0.65	-0.90	-0.98	-0.86	-0.51	-0.32	-0.32	-0.30	-0.29	1.0769	10 24
11 23	0.9231	0.18	0.09	-0.14	-0.45	-0.75	-0.94	-1.03	-0.94	-0.64	-0.35	-0.32	-0.30	-0.31	0.9231	11 23
12 22	0.7692	-0.12	-0.19	-0.36	-0.60	-0.84	-1.02	-1.06	-0.99	-0.77	-0.47	-0.33	-0.32	-0.32	0.7692	12 22
13 21	0.6154	-0.43	-0.48	-0.61	-0.79	-0.96	-1.07	-1.11	-1.05	-0.90	-0.66	-0.43	-0.35	-0.34	0.6154	13 21
14 20	0.4615	-0.74	-0.77	-0.85	-0.94	-1.04	-1.11	-1.13	-1.09	-1.00	-0.86	-0.70	-0.59	-0.54	0.4615	14 20
15 19	0.3077	-0.98	-0.99	-1.03	-1.07	-1.12	-1.15	-1.14	-1.14	-1.09	-1.02	-0.95	-0.90	-0.89	0.3077	15 19
16 18	0.1538	-1.12	-1.13	-1.14	-1.15	-1.15	-1.15	-1.14	-1.14	-1.13	-1.11	-1.10	-1.09	-1.08	0.1538	16 18
17 17	0.0	-1.17	-1.17	-1.18	-1.18	-1.18	-1.18	-1.17	-1.18	-1.18	-1.18	-1.18	-1.17	-1.17	0.0	17 17

TABLE 19

15.00 DEGREE CONE
UNIFORM FLOW 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.32379	0.24717	0.55764	0.40611	0.28585	-0.20381
2.31	-0.38920	0.34837	0.45746	0.44410	0.19810	-0.15639
2.15	-0.41671	0.37514	0.52818	0.44265	0.11215	-0.16002
2.00	-0.43825	0.43885	0.58290	0.42744	0.03487	-0.13394
1.85	-0.43743	0.47830	0.64869	0.36506	-0.00569	-0.09585
1.69	-0.44660	0.50947	0.69858	0.31557	-0.03431	-0.07237
1.54	-0.43655	0.46691	0.73173	0.27706	-0.05775	-0.06584
1.38	-0.44822	0.35826	0.78470	0.21202	-0.07188	-0.02795
1.23	-0.47096	0.23140	0.82140	0.14867	-0.06609	0.01886
1.08	-0.57684	0.11045	0.77191	0.07207	-0.04358	0.01804
0.92	-0.71666	0.05153	0.67479	0.02540	-0.01425	0.00349
0.77	-0.88112	0.02625	0.53004	-0.00062	-0.00305	0.00737
0.62	-1.06686	0.00413	0.37595	0.00337	-0.00004	0.00536
0.46	-1.22229	0.01311	0.21216	-0.00500	0.00493	-0.00056
0.31	-1.34974	0.00871	0.09488	0.00533	0.00068	0.00220
0.15	-1.41318	-0.00282	0.02229	-0.00016	0.00350	0.00012
0.0	-1.45400	-0.00000	0.00209	-0.00000	0.00359	-0.00000

TABLE 20

30.00 DEGREE CONE
UNIFORM FLOW 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.28851	0.30576	0.44381	0.29620	0.25110	-0.02276
2.31	-0.36065	0.41298	0.35589	0.35870	0.17071	-0.04865
2.15	-0.39144	0.43536	0.42394	0.35025	0.10046	-0.07498
2.00	-0.40366	0.50764	0.47974	0.33433	0.03493	-0.07712
1.85	-0.42260	0.55642	0.56110	0.31416	0.00693	-0.06380
1.69	-0.43691	0.57887	0.62741	0.29053	-0.02387	-0.05500
1.54	-0.43804	0.53802	0.66455	0.27083	-0.04722	-0.06383
1.38	-0.45372	0.42408	0.71678	0.22538	-0.06949	-0.03777
1.23	-0.47209	0.25183	0.77045	0.14722	-0.07459	0.01000
1.08	-0.56866	0.12603	0.74749	0.08281	-0.05514	0.02699
0.92	-0.70908	0.06499	0.65598	0.03324	-0.02507	0.01213
0.77	-0.87478	0.02287	0.52671	-0.00117	-0.00415	0.00554
0.62	-1.06071	-0.00591	0.37667	-0.00468	0.00793	-0.00382
0.46	-1.21657	-0.00765	0.22140	-0.01863	0.01112	-0.00912
0.31	-1.34236	0.00738	0.09754	0.00203	-0.00152	-0.00188
0.15	-1.41091	-0.00711	0.02521	-0.00296	0.00188	-0.00229
0.0	-1.45489	-0.00000	0.00429	0.0	0.00214	-0.00000

TABLE 21

15.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.23846	0.14257	0.42326	0.31374	0.06753	-0.09843
2.31	-0.26368	0.14456	0.36197	0.29496	0.05176	-0.08611
2.15	-0.28259	0.14301	0.36142	0.30187	0.02959	-0.09427
2.00	-0.28387	0.16709	0.39182	0.29167	0.01160	-0.09345
1.85	-0.27406	0.21741	0.41903	0.27898	-0.00736	-0.08067
1.69	-0.27430	0.27242	0.47321	0.26382	-0.03373	-0.06184
1.54	-0.27119	0.30886	0.52166	0.25182	-0.05101	-0.04329
1.38	-0.29257	0.30685	0.55523	0.24151	-0.06524	-0.03345
1.23	-0.33518	0.27097	0.55755	0.22372	-0.07749	-0.01792
1.08	-0.41544	0.19667	0.54458	0.19127	-0.08788	0.00607
0.92	-0.51310	0.09716	0.51783	0.14595	-0.08569	0.02584
0.77	-0.62656	-0.00798	0.46504	0.08351	-0.06338	0.03567
0.62	-0.77846	-0.10342	0.40419	0.01451	-0.01913	0.02191
0.46	-0.94084	-0.09430	0.25833	-0.01835	0.00557	-0.00255
0.31	-1.10030	-0.04465	0.12088	-0.00731	0.00164	0.00043
0.15	-1.18887	-0.02453	0.02092	-0.00046	0.00255	0.00148
0.0	-1.24542	-0.00000	-0.00177	-0.00000	-0.00092	-0.00000

TABLE 22

30.00 DEGREE CONE
1/6 POWER GRADIENT 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.20502	0.17975	0.29475	0.21207	0.14557	-0.00301
2.31	-0.24451	0.21628	0.22919	0.22406	0.10423	-0.01525
2.15	-0.27351	0.20139	0.25632	0.22621	0.06832	-0.04135
2.00	-0.28800	0.23087	0.29387	0.21660	0.03355	-0.05316
1.85	-0.29583	0.28059	0.36074	0.22781	0.00961	-0.05406
1.69	-0.28819	0.33808	0.43472	0.22176	-0.01556	-0.04347
1.54	-0.28628	0.36334	0.49581	0.22226	-0.03895	-0.03424
1.38	-0.30722	0.35039	0.53853	0.21579	-0.05484	-0.02562
1.23	-0.35044	0.29823	0.56073	0.19530	-0.07006	-0.00754
1.08	-0.42991	0.21485	0.55559	0.16490	-0.07769	0.01772
0.92	-0.53192	0.12035	0.52839	0.11963	-0.07133	0.03355
0.77	-0.65505	0.01786	0.47236	0.05809	-0.04714	0.03563
0.62	-0.81300	-0.06993	0.40398	-0.00059	-0.00583	0.01306
0.46	-0.97869	-0.05536	0.24695	-0.01498	0.00811	0.00018
0.31	-1.13126	-0.02375	0.11403	-0.00354	0.00398	-0.00005
0.15	-1.21570	-0.01621	0.02150	0.00021	0.00313	0.00077
0.0	-1.27170	-0.00000	0.00192	-0.00000	0.00218	-0.00000

TABLE 23

15.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.21166	0.13653	0.37785	0.27717	0.04097	-0.08325
2.31	-0.23643	0.11884	0.33919	0.26355	0.03603	-0.07836
2.15	-0.25797	0.11268	0.33219	0.26819	0.01189	-0.08183
2.00	-0.25081	0.13988	0.35222	0.25562	-0.00654	-0.08005
1.85	-0.24195	0.17852	0.37983	0.24769	-0.01726	-0.07266
1.69	-0.25238	0.22458	0.44999	0.24059	-0.06230	-0.05617
1.54	-0.24142	0.26338	0.46575	0.23160	-0.05099	-0.04071
1.38	-0.26160	0.26810	0.49632	0.22794	-0.06813	-0.03053
1.23	-0.29954	0.23810	0.50146	0.21628	-0.07950	-0.02072
1.08	-0.37157	0.17126	0.49128	0.18939	-0.08915	-0.00088
0.92	-0.45910	0.08091	0.46170	0.14917	-0.08613	0.01811
0.77	-0.56503	-0.01704	0.41855	0.08196	-0.06573	0.03662
0.62	-0.68565	-0.11893	0.36848	0.03099	-0.03635	0.02967
0.46	-0.83115	-0.14082	0.26173	-0.02241	0.00624	-0.00033
0.31	-0.99026	-0.07532	0.12250	-0.00781	0.00436	0.00025
0.15	-1.07854	-0.03928	0.02371	0.00184	-0.00076	0.00129
0.0	-1.13591	-0.00000	0.00005	-0.00000	0.00200	-0.00000

TABLE 24

30.00 DEGREE CONE
1/4 POWER GRADIENT 12/18/67

	HARMONIC NO.					
S	0	1	2	3	4	5
2.46	-0.18387	0.16276	0.27039	0.19219	0.12457	-0.00265
2.31	-0.20829	0.19290	0.20871	0.19699	0.08960	-0.01588
2.15	-0.23438	0.17965	0.23312	0.20111	0.05508	-0.04054
2.00	-0.25572	0.19572	0.26463	0.19347	0.02710	-0.04809
1.85	-0.25889	0.24439	0.32185	0.19624	0.00554	-0.04823
1.69	-0.25579	0.29530	0.39351	0.20112	-0.02056	-0.04209
1.54	-0.25683	0.32197	0.45131	0.20467	-0.04008	-0.03311
1.38	-0.27868	0.31581	0.49064	0.19970	-0.05562	-0.02366
1.23	-0.31923	0.27052	0.50930	0.18534	-0.06604	-0.00751
1.08	-0.39388	0.19785	0.50432	0.15637	-0.07405	0.01323
0.92	-0.48646	0.10966	0.48014	0.11611	-0.06915	0.03303
0.77	-0.59877	0.00920	0.43342	0.06250	-0.05222	0.03116
0.62	-0.73209	-0.07412	0.37531	0.00325	-0.01233	0.01908
0.46	-0.89298	-0.08090	0.24331	-0.02003	0.01047	-0.00184
0.31	-1.04423	-0.04337	0.11080	-0.00645	0.00206	0.00100
0.15	-1.12726	-0.02321	0.02061	0.00082	0.00398	0.00198
0.0	-1.17796	-0.00000	0.00142	-0.00000	0.00380	-0.00000

TABLE 25

LIFT AND DRAG COEFFICIENTS DETERMINED FROM INTEGRATION OF THE PRESSURE DISTRIBUTION COEFFICIENTS

Model and Test	C_L	C_D
15^o Sphere-Cone - Uniform Flow	0.742	0.490
30^o Sphere-Cone - Uniform Flow	0.667	0.549
15^o Sphere-Cone - 1/6 Power Flow	0.569	0.294
30^o Sphere-Cone - 1/6 Power Flow	0.540	0.361
15^o Sphere-Cone - 1/4 Power Flow	0.508	0.245
30^o Sphere-Cone - 1/4 Power Flow	0.499	0.319

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13. ABSTRACT

A series of wind tunnel tests on two radome models, composed of truncated spheres on conical bases, in both a uniform and two power law gradient flow conditions are described in this report. The data from these tests is presented in the form of actual pressure coefficients and as Fourier coefficients which have been best-fitted to the experimental data.

Comparisons are presented to show the manner in which these pressure distributions vary from each other for the differing model and flow conditions.

14. KEY WORDS

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